Claims

[c1] 1. A welding system comprising:
a welding unit including a welding torch positioned in proximity to a weld path on a component for forming a weldment along the weld path;
first means for moving the welding torch along the weld path;
at least one ultrasonic sensing device operatively mounted with the welding unit for ultrasonically sensing the proximity of a surface and producing a sensor output in proportion to the proximity of the surface;
second means for moving the welding torch relative to the weld path in directions normal to and transverse to the weld path; and
control means for receiving the sensor output from the ultrasonic sensing device, generating a control output based on the sensor output, and sending the control output to the second moving means to maintain the welding torch over the weld path and at a predetermined distance from the weld path during movement of the welding torch along the weld path by the first moving means.

[c2] 2. The welding system according to claim 1, wherein the surface sensed by the ultrasonic sensing device is a surface of the component spaced apart from the weld path.

[c3] 3. The welding system according to claim 1, wherein the surface sensed by the ultrasonic sensing device is a surface of the weld path.

[c4] 4. The welding system according to claim 1, wherein the control means comprises an input device for inputting to the control means a target value corresponding to the predetermined distance.

[c5] 5. The welding system according to claim 4, wherein the control means comprises interpolation means for comparing the sensor output to the target value and generating the control output by interpolation based on the comparison between the sensor output and the target value.

[c6] 6. The welding system according to claim 1, wherein the second moving means comprises an actuator coupled to the welding torch.

[c7] 7. The welding system according to claim 1, further comprising at least a second ultrasonic sensing device operatively mounted with the welding unit for ultrasonically sensing the position of the welding unit along the

weld path and producing a second sensor output in proportion to the position of the welding unit, wherein the control means comprises means for receiving the second sensor output from the second ultrasonic sensing device, generating a second control output, and sending the second control output to the first moving means.

[c8] 8. A welding system comprising:
a welding unit including a welding torch positioned in proximity to a weld path on a component for forming a weldment along the weld path;
first means for moving the welding torch along the weld path;
second means for moving the welding torch relative to the weld path in directions normal to and transverse to the weld path; at least a pair of ultrasonic sensing devices operatively mounted with the welding unit for ultrasonically sensing the proximity of at least two surfaces and producing sensor outputs in proportion to the proximities of the surfaces;
means for inputting target values corresponding to a predetermined distance desired between the welding torch and the weld path during movement of the welding torch along the weld path by the first moving means; and
a programmable logic controller programmed to receive the sensor outputs from the pair of ultrasonic sensing

devices, compare the sensor outputs to the target values, generate control outputs by interpolation based on the comparison between the sensor outputs and the target values, and send the control outputs to the second moving means to maintain the welding torch over the weld path and at the predetermined distance from the weld path during movement of the welding torch along the weld path by the first moving means.

[c9] 9. The welding system according to claim 8, wherein the surfaces sensed by the pair of ultrasonic sensing devices are surfaces of the component spaced apart from the weld path.

[c10] 10. The welding system according to claim 8, wherein the surfaces sensed by the pair of ultrasonic sensing devices are surfaces of the weld path.

[c11] 11. The welding system according to claim 8, further comprising an input device for inputting the predetermined distance to the programmable logic controller.

[c12] 12. The welding system according to claim 8, wherein the second moving means comprises at least two actuators coupled to the welding torch.

[c13] 13. The welding system according to claim 8, further comprising at least a second ultrasonic sensing device

operatively mounted with the welding unit for ultrasonically sensing the position of the welding unit along the weld path and producing a second sensor output in proportion to the position of the welding unit, wherein the programmable logic controller comprises means for receiving the second sensor output from the second ultrasonic sensing device, generating a second control output, and sending the second control output to the first moving means.

[c14] 14. A method of performing a welding operation, the method comprising the steps of:
positioning a welding torch of a welding unit a predetermined distance from a weld path on a component by ultrasonically sensing the proximity of at least one surface, producing a sensor output in proportion to the proximity of the surface, generating a control output on the basis of the sensor output, and using the control output to move the welding torch relative to the weld path in directions normal to and transverse to the weld path so as to obtain the predetermined distance between the welding torch and the weld path; and then
operating the welding torch to form a weldment along the weld path while the welding torch is moved along the weld path, the surface is ultrasonically sensed to produce the sensor output, and the control output is gener-

ated to move the welding torch relative to the weld path in directions normal to and transverse to the weld path to maintain the predetermined distance between the welding torch and the weld path.

[c15] 15. The method according to claim 14, wherein the surface ultrasonically sensed is a surface of the component spaced apart from the weld path.

[c16] 16. The method according to claim 14, wherein the surface ultrasonically sensed is a surface of the weld path.

[c17] 17. The method according to claim 14, further comprising ultrasonically sensing a position of the welding unit along the weld path and producing a second sensor output in proportion to the position of the welding unit, and generating a second control output based on the second sensor output to maintain movement of the welding torch along the weld path.

[c18] 18. The method according to claim 14, further comprising the steps of generating a target value corresponding to the predetermined distance, comparing the sensor output to the target value, and generating the control output by interpolation based on the comparison between the sensor output and the target value.

[c19] 19. The method according to claim 14, wherein the

welding torch is positioned the predetermined distance from the weld path and the control output is generated on the basis of the sensor output to obtain and maintain the predetermined distance between the welding torch and the surface using a programming sequence comprising the steps of:
scaling the sensor output relative to distance between the welding torch and the welding path and generating a range of scaled values therefrom;
inputting a targeted scaled value within the range of scaled values and corresponding to the predetermined distance;
obtaining the sensor output, generating an obtained scaled value corresponding to the sensor output, determining whether the obtained scaled value is equal to, greater than, or less than the targeted scaled value, and moving the welding torch until the predetermined distance is obtained by interpolation of the obtained scaled value relative to the targeted scaled value.

[c20] 20. The method according to claim 14, wherein the positioning and operating steps further comprise ultrasonically sensing the proximity of a second surface, producing a second sensor output in proportion to the proximity of the second surface, generating a second control output on the basis of the second sensor output, and

using the second control output to assist in obtaining and maintaining the predetermined distance between the welding torch and the weld path.